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Before the
Federal Communications Commission
Washington, D.C. 20554

In the Matter of	)	
	)	MM Docket No. 97-217
Amendment of Parts 1, 21 and 74 to Enable Multipoint Distribution Service and Instructional Television Fixed Service Licensees to Engage in Fixed Two-Way Transmissions	)	

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OFFICE OF THE SECRETARY

COMMENTS OF SPIKE TECHNOLOGIES, INC.

Spike Technologies, Inc. ("Spike"), by its attorneys and pursuant to Section 1.415 of the Commission's Rules, hereby submits its Comments in response to the Commission's Public Notice inviting additional comment on the *ex parte* presentations made and filed subsequent to the expiration of the initial comment period in this proceeding.[1]

Introduction

Spike, which filed Comments and Reply Comments previously in this proceeding, is a manufacturer of microwave equipment for two-way wireless communications.[2] Through its subsidiary, Third-Rail Wireless Services, Inc., Spike also designs two-way wireless communications systems and integrates advanced computer networking and diagnostic equipment into such systems.[3] Spike's technical facilities are located at Nashua, New Hampshire, and PRIZM-equipped communications systems are currently operating and providing a variety of advanced two-way

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[1] *Public Notice*, DA-98-1119, released June 12, 1998.

[2] Spike's PRIZM100 transceiver for two-way use on MDS and ITFS frequencies was recently type-accepted by the Commission.

[3] Spike's PRIZM broadband delivery systems recently captured two of twelve SuperQuest awards at SuperComm98. These awards honor service providers and enterprise end users for innovative use of technology in communications networks and services.

services there and in South America.

In its Comments, Spike noted that its own hands-on, practical experience with two-way communications utilizing "wireless cable" spectrum made Spike uniquely qualified to comment on the matters at issue in this proceeding.[4] Spike has supported Petitioners'[5] proposed two-way technical rules, with certain refinements aimed at further enhancing future services provided over MDS and ITFS frequencies.

At this juncture, however, there remains an inconsistency that if not clarified could result in the adoption of rules that would cause digital MDS and ITFS equipment to be unnecessarily expensive to design and manufacture. This issue – which Spike addressed in its Reply Comments[6] - concerns the emission mask and the required level of attenuation of out-of-band emissions. Resolution of this issue will greatly facilitate implementation of new two-way services.

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[4] *See* Spike Comments at 2.

[5] This rulemaking proceeding was initiated at the request of over one hundred participants in the wireless cable and related industries, including the Wireless Cable Association International, Inc., wireless cable system operators, MDS and ITFS licensees, equipment manufacturers, engineers, and others (collectively, "Petitioners").

[6] *See* Spike Reply Comments at 6-8.

Discussion

Although the NPRM[7] and the digital Declaratory Ruling and Order ("DDR")correctly define the attenuation of out-of-band emissions as being relative to the licensed *average power level*, the "flat top" of the digital wave form is mistakenly used as the reference level for the spectral mask.[8] Because the "flat top" is merely the average level of the digital wave form and does not represent the licensed average power level,[9] the use of the flat top of the digital wave form results in an emission mask standard nearly 18 dB more stringent than ever intended.[10] This will make it more difficult and

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[7]The NPRM was initiated at the request of over one hundred participants in the wireless cable and related industries, including the Wireless Cable Association International, Inc., wireless cable system operators, MDS and ITFS licensees, equipment manufacturers, engineers, and others (collectively, "Petitioners").

[8]*See* DDR at paragraph 27, NPRM at Appendix C, § 21.908. *See* also. Petitioners' *ex parte* filing of May 22, 1998, Appendix C, Note 1:

"For absolute power measurements:

Attenuation in dB (below channel power) = $A + 10_{\log} (C_{BW} / R_{BW})$

For relative power measurements:

Attenuation in dB (below flat top) = $A + 10\log(R_{BW1}/R_{BW2})$

Where:

A= Attenuation specified for spectral point (e.g., 35, 38,60 dB)

C_{BW} = Channel bandwidth (for absolute power measurements)

R_{BW} = Resolution bandwidth (for absolute power measurements)

R_{BW1} = Resolution bandwidth for flat top measurement (relative)

R_{BW2} = Resolution bandwidth for spectral point measurement (relative)"

Employing these equations results in the spectral mask being erroneously referenced to the "flat top."

[9]The licensed average power level has been defined as being equal to the peak analog visual power, or 2000 W EIRP. *See* Petitioners' *ex parte* filing of May 22, 1998, Appendix C § 21.908. *See also* DDR at 27.

[10]Using a 100 kHz resolution bandwidth; 28 dB if a 10 kHz resolution bandwidth is employed. Since the "flat top" is a power spectral density and not an absolute power level, the resolution bandwidth of the spectrum analyzer affects the level of the "flat top" relative to the actual integrated channel power.

expensive to utilize existing transmission equipment in the conversion to digital services and more costly to design and manufacture new equipment. This is contrary to the FCC's stated goal of expediting the delivery of digital services to the public.[11]

Figure 1 (attached hereto as Exhibit A) illustrates various relationships between analog and digital signals.[12] Depicted are an analog signal with digital signals on the adjacent channels. It should be noted that the data reflects post-transmitter output measured after various losses in the test setup. The analog peak video level of -21 dBm is measured using a 10 kHz resolution bandwidth. Recognizing that -21 dBm is not the actual transmitter level (having been reduced by the test setup), one can refer to this level as the "licensed level" for purposes of this discussion.[13] It is important to note also that the digital signals have had their total digital channel power adjusted to be at the "licensed level." Pursuant to the DDR, it is the analog licensed power level that defines authorized digital signal power (average digital channel power).

$$\begin{aligned} \text{Average Digital Channel Power} \quad &= \text{Average flat top} + 10 \log_{10} (C_{bw}/R_{bw}) \\ &= -49 \text{ dBm} + 10 \log_{10} (6\text{MHz}/10\text{kHz}) \\ &= -49 \text{ dBm} + 27.78 \text{ dB correction factor} \\ \text{Average Digital Channel Power} \quad &= -21.2 \text{ dBm} \end{aligned}$$

This level is represented by the (red) shaded line on Figure 1.

For QAM and VSB modulation, irregularly occurring peak levels can exceed average power

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[11] *See* DDR at paragraphs 25 and 27.

[12] Figure 1 is based upon an illustration which appeared as Figure 13 in the Petition for Declaratory Ruling ("Digital Petition") which ultimately resulted in issuance of the DDR.

[13] The digital signals shown on the plot were measured at the same point in the test setup, after having been passed through a prototype combining filter. It should be noted that in sectored systems, a separate transmitter is used for each sector and combining filters are not required.

level values by 5 to 10 dB.[14] The actual peak to average power ratio depends on the modulation level and on the excess bandwidth factor, alpha. For lower order QAM, the peak to average ratio is approximately 5 to 6 dB. Both the total digital channel power and the flat top of the spectral wave form have peak levels 5 to 6 dB higher than their average levels. This is illustrated with the addition of the (blue) shaded lines in Figure 1.

If the spectral mask and attenuation of out-of-band emissions are treated as being relative to the flat top of the digital wave form instead of to licensed average power level, significant additional equipment expenses are likely to be incurred. For example, Local Oscillator (" LO") leakage signals are a common and well understood source of out-of-band spurious energy. An LO is used to frequency-convert an intermediate frequency signal to RF energy for transmission purposes. Current rules require analog facilities to maintain LO leakage levels (and any other out-of-band spurious energy) within the analog spectral mask.

Figure 2 (Exhibit B hereto)[15] shows that where these LO spurs occur, 60 dB of attenuation from the analog peak level is required for analog mask compliance (green line). Upon conversion to digital signal transmissions, channel power will be spread across the channel and evidence the same 60 dB of attenuation provided by the analog equipment. Because LO leakage signals are always analog and consist of a single tone rather than a power spectral density, no power spreading occurs and such signals are measured at the same power level as during analog operation. As a result, additional attenuation at the LO spur frequency is required because the spectral mask has been

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[14]Digital Petition, Appendix B, at 2 and 8; DDR at 28.

[15]Figure 2 is also based upon an illustration which appeared as Figure 13 in the Digital Petition.

lowered[16] by virtue of a measurement technique that references the flat top of the digital spectral wave form rather than the licensed average power level. The amount of additional attenuation required and associated additional equipment expense will depend on the amount of margin existing under the analog mask and how close the LO spur is to the channel edge, but could be substantial.

Spike is unable to discern from the NPRM or from the proposed rules that the Commission or the Petitioners actually intended stricter out-of-band emission standards. Such seems unlikely because to do so could delay the introduction of advanced two-way services, require additional equipment expense, and result in services that are less competitive commercially, with no corresponding public benefit.

In an effort to further assist the Commission in resolving the inconsistency in spectral mask reference level, Spike performed a mathematical analysis of out-of band emission profiles, attached as Exhibit C hereto. The first part of this analysis quantifies the worst-case interference power presented to an analog signal by other analog signals, occupying upper and lower adjacent channels. For the purpose of this analysis, all signals are considered to be of equal power and to be at the adjacent channel 0 dB D/U ratio. Each of the upper and lower channel signals will supply adjacent channel power as defined by the analog mask. This signal is spurious and noise-like in nature and virtually all of its energy is found in the triangular areas of the mask defined by the 38 and 60 dB points. Numerical integration of these areas yields the total worst-case interfering power introduced into the adjacent channel allowed under the current rules. This power is shown to be equivalent to a single tonal signal with a level that is -32.4 dBc from the NTSC peak visual level.

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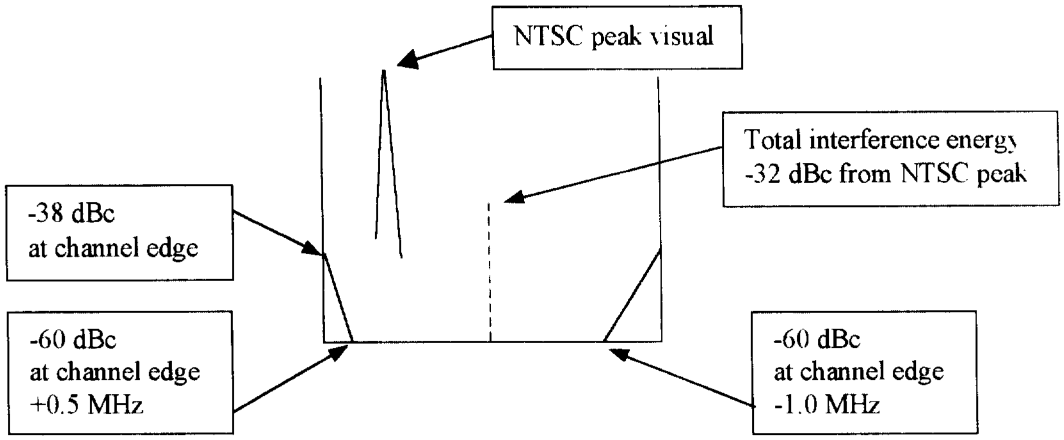
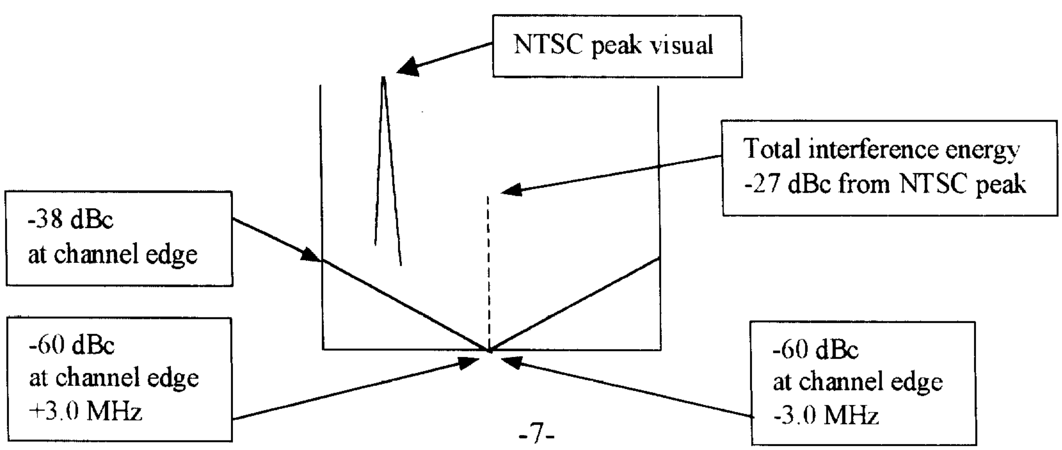
[16] 6 MHz channel, 10 kHz resolution bandwidth = 27.8 dB



The second part of the Exhibit C analysis quantifies the interference power presented to an analog signal by other *digital* signals, occupying upper and lower adjacent channels. All signals are considered to be of equal channel power and to be at the adjacent channel 0 dB D/U ratio. Each of the upper and lower channel signals will supply adjacent channel power as defined by the digital spectral mask. Again, virtually all of this power is found in the triangular areas of the mask as defined by the 38 and 60 dB points. The analysis sets the digital spectral mask at the licensed average digital channel power and is equal to the NTSC peak level. Numerical integration of these areas yields the total worst-case interfering power introduced to the adjacent channel. This power to shown to be equivalent to a single tonal signal with a level that is -27 dBc from the NTSC peak visual level.



Recognizing a 5.4 dB difference between the above-described digital and analog out-of-band emission power levels, it is important to consider that the analysis assumes that the digital signal is at an average channel power equal to the peak NTSC level. As previously and correctly noted in the Digital Petition and DDR, the average digital channel power will, by necessity, be "backed off" from the licensed NTSC peak level to allow room for peak excursions of the digital signal without distortion or clipping.[17] This back-off will be on the order of 5 to 10 dB, depending on the actual modulation method and actual transmitter equipment utilized. As the digital signal power is reduced in level, the energy introduced into the adjacent channel is correspondingly reduced on at least a dB for dB basis. For all practical purposes, the energy introduced into the adjacent channel by digital signals will be equal to currently-permissible power from adjacent channel analog signals. This analysis further demonstrates that referencing the spectral mask to the licensed average power level rather than to the flat top of the digital wave form is appropriate.[18]

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[17] *See* Digital Petition, Appendix B, pp 2 and 8; DDR at 28.

[18] Spike agrees with Petitioners that "[s]hould harmful interference occur as a result of emissions outside of the assigned channel, additional attenuation is required." *See* Petitioners' *ex parte* filing of May 22, 1998, Appendix C § 21.908(b).

Conclusion

It is critical that the Commission take this opportunity to clarify that out-of-band emission attenuation continues to be relative to the licensed average digital power level and is equal to the licensed analog peak visual level. This clarification will ensure consistency in the rules and greatly facilitate the transition to advanced two-way operations.

Respectfully submitted,

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EXHIBIT A
Figure 1

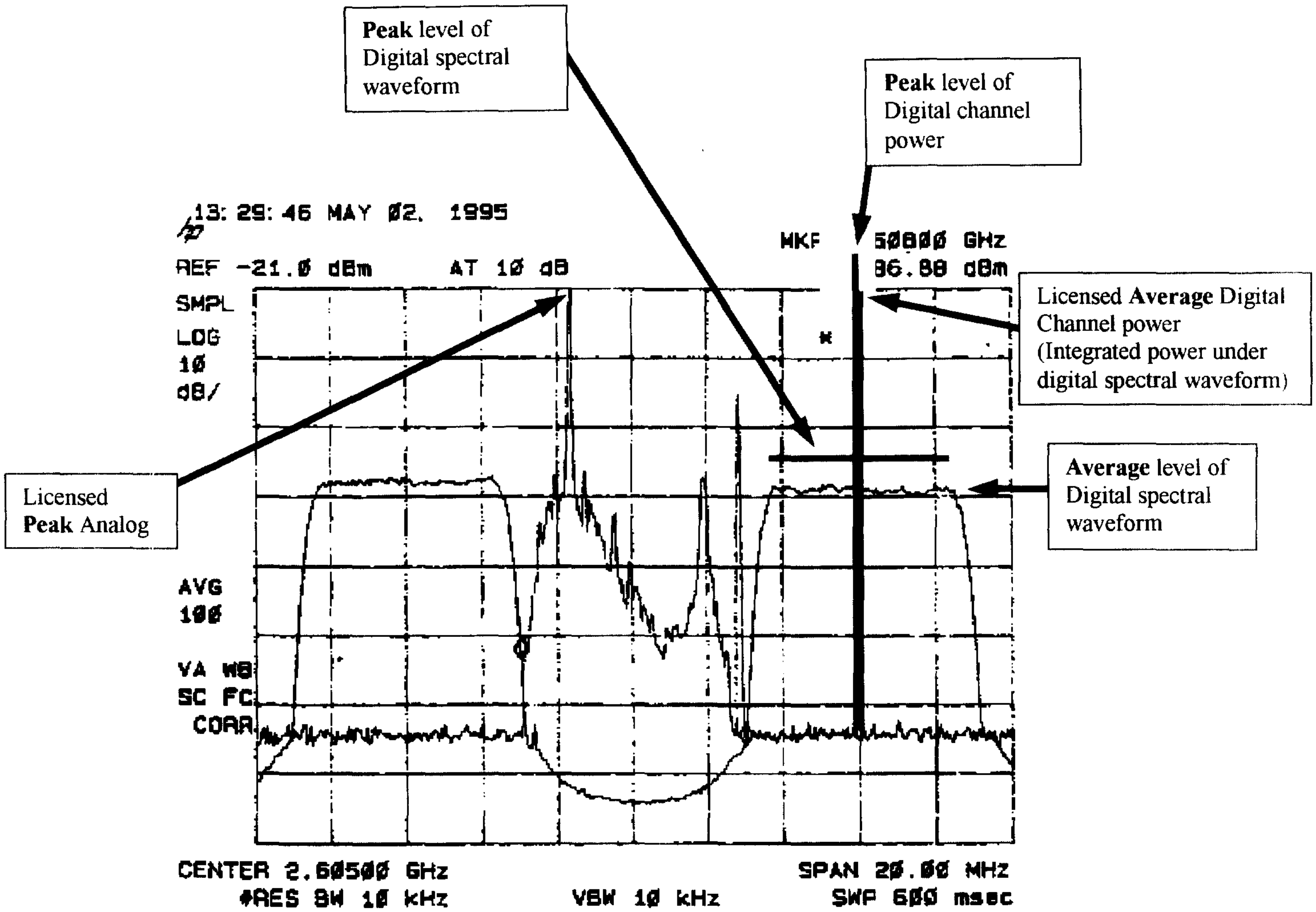


Figure 13 -- Relative Levels of NTSC and 64-QAM Signals w/10 kHz Resolution Bandwidth (27.78 dB correction factor required for digital signal levels)

FIGURE 1

EXHIBIT B

Figure 2

EXHIBIT C

Appendix A Part 1 6/30/98

Calculate total interference power from the adjacent two bands using the power spectral density mask for analog signals.

First: calculate the power spectral density mask for the out of band portion of the existing spectral mask. For simplicity we will restrict the out of band region to one channel width either side of the desired 6 MHz channel.

Calculate integrated power for lower side band with slope reaching -60 dbc at 4 MHz from band center and sloping to -38 dbc at the 3 MHz band edge.

$Freq\_Step \quad 100$ $\qquad RBW \quad 100000$

$$f \quad 0 .. \frac{6000000}{Freq\_Step} \quad 1$$

$SPD4MHz \quad 60$ power spectral density in dBc at 4 MHz from channel center frequency

$SPD3MHz \quad 38$ power spectral density in dBc at 3 MHz from channel center frequency (band edge)

$$k \quad 0 .. \frac{5000000}{Freq\_Step} \quad 1$$

Calculate flat portion of spectral mask outside of 4 MHz

$$Mask_k \quad 10^{\frac{SPD4MHz}{10}}$$

Calculate rising portion of spectral mask inside of 4 MHz from Band enter to band edge

$$l \quad \frac{5000000}{Freq\_Step} .. \frac{6000000}{Freq\_Step}$$

$$slope \quad \frac{SPD3MHz \quad SPD4MHz}{\frac{6000000}{Freq\_Step} \quad \frac{5000000}{Freq\_Step}}$$

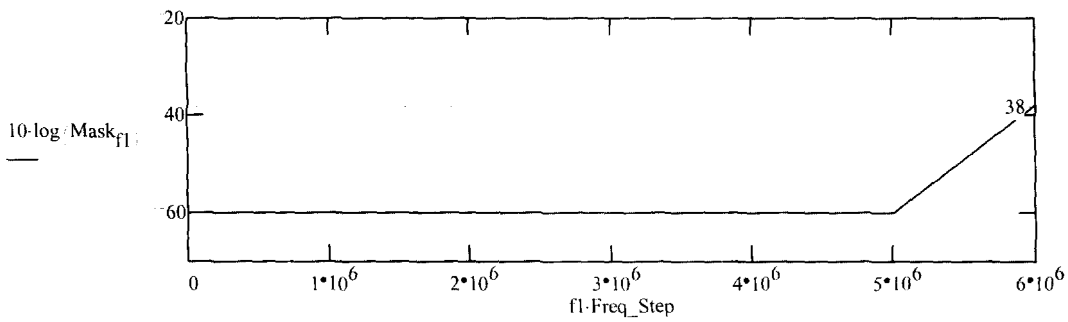
$$slope = 2.2 \cdot 10^{3}$$

$$B \quad SPD4MHz \quad slope \cdot \frac{5000000}{Freq\_Step}$$

$$maskdb_l \quad slope \cdot l + B$$

$$Mask_l \quad 10^{\frac{maskdb_l}{10}}$$

$f1 := 0 .. \frac{6000000}{Freq\_Step}$ Plot lower side spectral mask

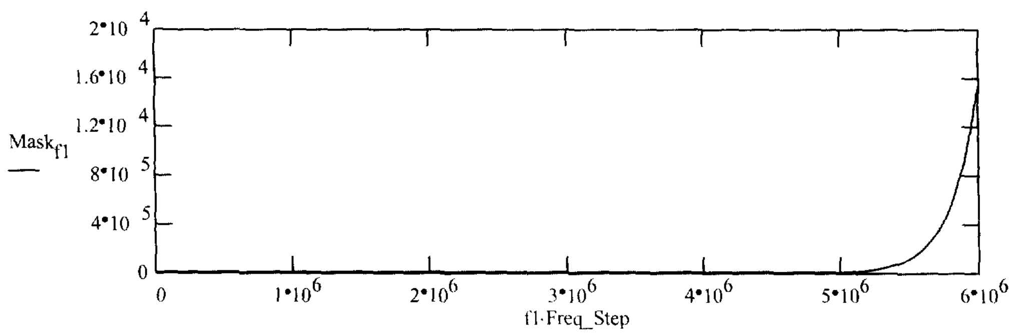


Adjacent Channel
lower edge

Channel edge

$$P\_intf\_side1 := \frac{Freq\_Step}{RBW} \cdot \sum_{f} Mask_{f}$$

$$P\_intf\_side1 = 3.608 \cdot 10^{4}$$



Linear plot of out of band spectral mask limit

Second: calculate the power spectral density mask for the out of band portion of the existing spectral mask.
Calculate integrated power for upper side band with slope reaching -60 dbc at 3.5 MHz from band center and sloping to -38 dbc at the 3 MHz band edge.

$\mathrm{SPD35MHz}\quad 60$ power spectral density in dBc at 3.5 MHz from channel center frequency

$\mathrm{SPD3MHz}\quad 38$ power spectral densityin dBc at 3 MHz from channel center frequency (band edge)

$k\ \ 0..\dfrac{5500000}{\mathrm{Freq\_Step}}\quad 1$ Calculate flat portion of spectral mask outside of 3.5 MHz

$$\mathrm{Mask}_k\quad 10^{\frac{\mathrm{SPD4MHz}}{10}}$$

Calculate rising portion of spectral mask inside of 3.5 MHz from Band enter to band edge

$$\mathrm{slope}\quad \frac{\mathrm{SPD3MHz}\quad \mathrm{SPD35MHz}}{\dfrac{6000000}{\mathrm{Freq\_Step}}\quad \dfrac{5500000}{\mathrm{Freq\_Step}}}$$

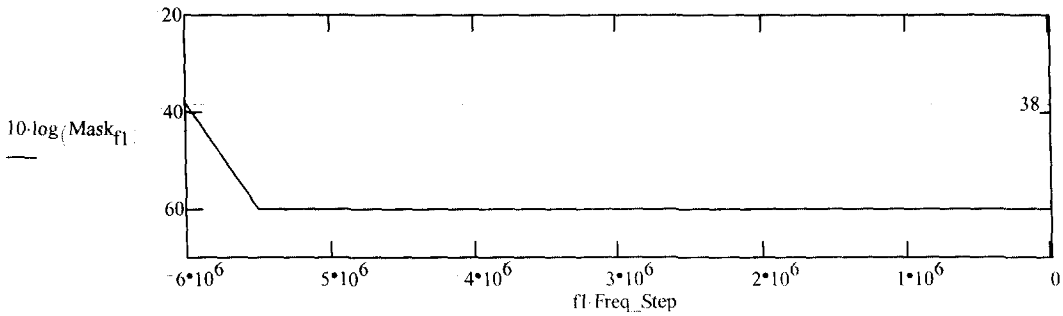
$$l\quad \frac{5500000}{\mathrm{Freq\_Step}}..\frac{6000000}{\mathrm{Freq\_Step}}\quad 1$$

$$\mathrm{slope} = 4.4\cdot 10^{\ 3}$$

$$B\quad \mathrm{SPD35MHz}\quad \mathrm{slope}\cdot\frac{5500000}{\mathrm{Freq\_Step}}$$

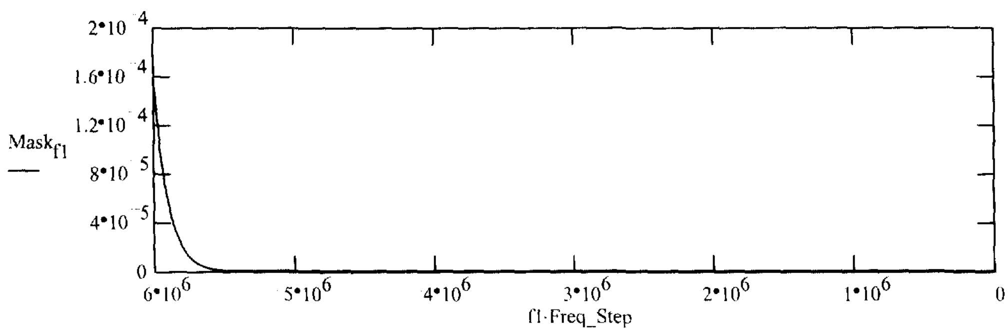
$$\mathrm{maskdb}_l\quad \mathrm{slope}\cdot l\ \ B$$

$$\mathrm{Mask}_l\quad 10^{\frac{\mathrm{maskdb}_l}{10}}$$



Channel edge

Adjacent Channel
upper edge



Linear plot of out of band spectral mask limit

$$P\_intf\_side2 = \frac{Freq\_Step}{RBW} \cdot \sum_{f} Mask_f$$

$P\_intf\_side2 = 2.104 \cdot 10^{4}$

Sum the power from both upper and lower channel out of band inteference

$$P\_intf\_total = P\_intf\_side2 + P\_intf\_side1$$

convert to Signal to Interference Ratio relative to desired signal at 0 dbc in channel

$10 \cdot \log(P\_intf\_total) = 32.432$ dbc SIR analog spectral mask worst case

Part 2

Calculate total interference power in band from a power spectral density mask for DIGITAL signal
First calculate the power spectral density mask. For simplicity we will calculate for a 100 KHz resolution bandwidth and restrict the out of band region to one channel width either side of the desired 6 MHz channel.
Calculate integrated power for lower side band with slope reaching -60 dbc at 3 MHz from band center

$$Freq\_Step = 100$$

$$f \quad 0 .. \frac{6000000}{Freq\_Step} \quad 1$$

$SPD6MHz \quad 60$ power spectral density in dBc at 6 MHz from channel center frequency

$SPD3MHz \quad -38$ power spectral density in dBc at 3 MHz from channel center frequency (band edge)

$$k \quad 0 .. \frac{3000000}{Freq\_Step} \quad 1$$

Calculate flat portion of spectral mask outside of 6 MHz

$$Mask_k \quad \left(10^{\frac{SPD6MHz}{10}}\right)$$

Calculate rising portion of spectral mask inside of 3 MHz from band edge

$$l \quad \frac{3000000}{Freq\_Step} .. \frac{6000000}{Freq\_Step} \quad 1$$

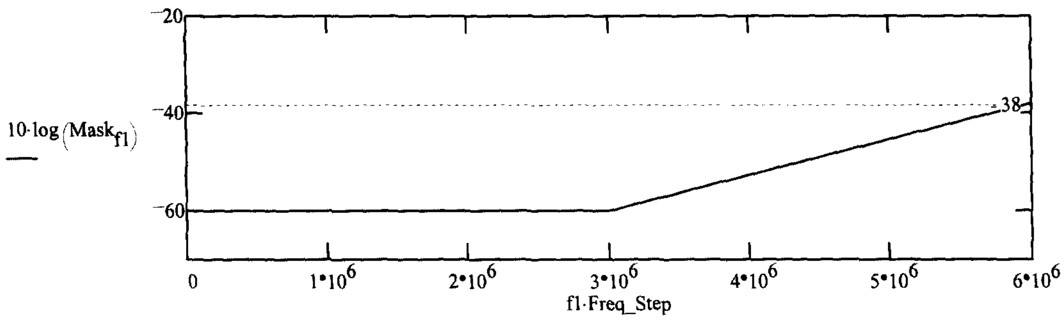
$$slope \quad \frac{SPD3MHz \quad SPD6MHz}{\left(\frac{6000000}{Freq\_Step}\right) \quad \left(\frac{3000000}{Freq\_Step}\right)}$$

$$slope = 7.333 \cdot 10^{4}$$

$$B \quad SPD6MHz \quad slope \cdot \frac{3000000}{Freq\_Step}$$

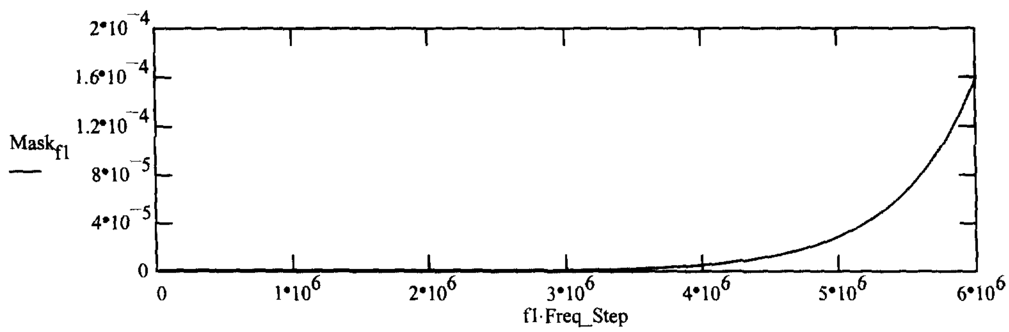
$$maskdb_l \quad slope \cdot l \quad B$$

$$Mask_l \quad \left(10^{\frac{maskdb_l}{10}}\right)$$



Adjacent Channel
lower edge

Channel edge



Linear plot of out of band spectral mask limit

due to the symetry in the spectral mask the two sided
power level is just twice the single sided version

$$P\_intf\_2sided := \frac{Freq\_Step}{RBW} \cdot 2 \cdot \sum_{f} Mask_f$$

$$P\_intf\_2sided = 1.925 \cdot 10^{-3}$$

convert to Signal to Interference Ratio relative to desired signal at 0 dbc in channel

$10 \cdot \log(P\_intf\_2sided) = -27.155$ dbc SIR digital spectral mask worst case

CERTIFICATE OF SERVICE

I, Yvette King, a secretary with the law firm of Rini, Coran & Lancellotta, P.C., do hereby certify that I caused a copy of the foregoing "Comments of Spike Technologies, Inc." in MM Docket No. 97-217 to be mailed first-class, postage prepaid, this 2nd day of July, 1998 to the following:

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